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or that

$$\begin{aligned} &a[c_0 + c_1 + c_2 + c_3 + \cdots + c_n] \\ &+ \Delta_1[c_1 + c_2\cdot 2 + c_3\cdot 3 + \cdots + c_n\cdot n] \\ &+ \Delta_2\left[c_2 + c_3\cdot 3 + c_4\cdot 6 + \cdots + c_n \frac{n(n-1)}{2!} \right] \\ &\cdots\cdots\cdots\cdots\cdots\cdots \\ &+ \Delta_k[c_k + c_{k+1}\cdot c_1^{k+1} + c_{k+2}\cdot c_2^{k+2} + \cdots + c_n\cdot c_{n-k}^{n}] = 0, \end{aligned}$$

where k is used for r, and $c_{n-k}^{n} = \binom{n}{n-k}$. Now, each of the quantities in the brackets is equal to zero; for, the general form of the bracketed expressions is $c_k + c_{k+1}\cdot c_1^{k+1} + c_{k+2}\cdot c_2^{k+2} + \cdots + c_n^{n}\cdot c_{n-k}$ and this is equal to $c_k[1 - c_1^{n-k} + c_2^{n-k} - \cdots (-1)^{n-k} c_{n-k}^{n-k}] = c_k^{n}(1-1)^{n-k} = 0$, for $n > k$.

Also solved by A. M. HARDING, E. E. WITMER, and the Proposer.

Note by the Editor: The solution of Mr. Pelletier does not differ greatly from solution I by Mr. E. H. Clarke. Problem 481 (Algebra) [May, 1917], also proposed by Mr. Moore, is really the same as problem 2699 (or 2710), and has been solved by Professor F. H. SAFFORD.

2702 [May, 1918]. Proposed by N. P. PANDYA, Sojitra, India.

A conic of variable eccentricity has a focus and corresponding directrix fixed. The latus rectum cuts a fixed circle in A' and B'. If A be the vertex of the conic, find the locus of the centroid of the triangle $AA'B'$.

SOLUTION BY H. L. OLSON, Chicago, Illinois.

If the directrix be taken as the y axis and the perpendicular from the focus to the directrix as the x axis, the equation of the conic may be written,

$$\{(1-e^2)x - k\}^2 + (1-e^2)y^2 = k^2e^2,$$

where k is the (fixed) perpendicular distance from the focus to the directrix. Let the equation of the fixed circle be $(x-p)^2 + (y-q)^2 = r^2$. The latus rectum, $x = k$, of the conic cuts this circle in the points for which $x = k$, $y = q \pm \sqrt{r^2 - (k-p)^2}$. The coördinates of the vertex A of the conic are $x = k/(1+e)$, $y = 0$. Hence, the coördinates of the centroid of the triangle $AA'B'$ are

$$x = \tfrac{2}{3}k + \frac{k}{3(1+e)}, \qquad y = \tfrac{2}{3}q,$$

and its locus is the straight line $y = \frac{2}{3}q$.

Also solved by A. M. HARDING.

2703 [May, 1918]. Proposed by S. A. COREY, Albia, Iowa.

Let A_1, A_2, A_3, A_4 and $-(A_1 + A_2 + A_3 + A_4)$ be the vector sides of a pentagon, plane or gauche. Let B_1, B_2, B_3, B_4 and $-(B_1 + B_2 + B_3 + B_4)$ be the sides of a second pentagon where

$$B_1 = (c_1 + c_2)A_1 + (c_1 - c_2)A_3, \qquad B_2 = (c_4 + c_3)A_4 + (c_4 - c_3)A_2,$$
$$B_3 = (c_2 + c_1)A_2 + (c_2 - c_1)A_4, \qquad B_4 = (c_3 + c_4)A_3 + (c_3 - c_4)A_1,$$

c_1, c_2, c_3, and c_4 being ordinary scalars.

Then, if a_r and b_s be the lengths of the sides A_r and B_s respectively and if $\cos A_rA_s$ denotes the cosine of the angle included between the sides A_r and A_s and if $\cos B_rB_s$ denotes the cosine of the angle included between the sides B_r and B_s prove that

$$2(c_1c_4 + c_2c_3)(a_1a_4 \cos A_1A_4 + a_2a_3 \cos A_2A_3) = b_1b_2 \cos B_1B_2 + b_3b_4 \cos B_3B_4.$$